Short Communication

Association of Body Mass, Serum Insulin, and Lipid Profile with Serum Melatonin Levels in Individuals in Babylon, Iraq

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Abstract

Background: Melatonin has been shown to directly affect metabolism and body weight management, in addition to its established involvement in circadian rhythm. **Objectives:** We aimed to investigate the relationship between serum melatonin and adult BMI, serum insulin, and lipid profile (cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and TG). **Materials and Methods:** In this cross-sectional study, 150 individuals (78 females and 72 males) aged 18–60 were recruited. Samples were collected at Imam al-Sadiq Hospital and Marjan Hospital in Babylon Governorate from September 1, 2023, to June 30, 2024. Patients' metabolic blood parameters, such as insulin, triglycerides, HDL, LDL, HB, urea, creatinine, and cholesterol, were measured and their association with serum melatonin determined. **Results:** This study included a total of (150) patients, with the mean age of participants (32.0 ± 7.9) years and a median age of (31) years. Regarding gender distribution, the proportion of female patients was 52.0% compared to males (48.0%). Mean BMI of study patients was (30.6 ± 8.3) kg/m^2. The majority (60.7%) of patients were obese (BMI ≥ 30). There was a significant difference among age groups, with a *P* value of 0.006. Comparison between males and females regarding serum melatonin level indicated that there were no significant differences between them. In a similar manner, no significant difference was observed between urban residents (11.7 ± 11.7) and rural residents (26.9 ± 10.7). **Conclusion:** A correlation was observed between insulin resistance and melatonin secretion; groups with elevated BMI with higher melatonin levels also had higher insulin resistance. Also, higher melatonin concentrations in the serum, insulin excess (overweight), and a high lipid profile, along with low vitamin D, were observed. The high BMI group has low vitamin D, whereas normal BMI group has normal vitamin D. Thus, overweight (high BMI) people tend to have lower vitamin D levels.

Keywords: BMI, lipid profile, melatonin, obesity, serum insulin

Introduction

Melatonin is a natural hormone that is mainly produced by the pineal gland in the brain. It plays a role in managing our sleep–wake cycle and circadian rhythm. Scientists still have much to learn about all of its effects on the human body.[1] Melatonin's anti-obesogenic and weight-loss effects seem to be linked to the regulation of circadian rhythms in peripheral adipose tissues. Melatonin has the ability to alter immune responses, emphasizing the way in which the immune system and metabolic pathways interact.[2]

In mammals, melatonin affects body mass management and energy expenditure. Thermogenic activation of brown adipose tissue has been linked to melatonin-induced reduction in fat mass in Djungarian and Syrian hamsters.[3] Because overweight individuals are more prone to infections, the positive effects of this interaction are especially significant in boosting the immune response.

Obesity has increased in women of reproductive age, and being overweight during pregnancy has been associated

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with several maternal and fetal complications.[4] The biochemical, hormonal, immunological, and nutritional components of human colostrum and milk also seem to change as a result of being overweight during pregnancy.[5]

Melatonin, one of the hormones contained in milk, plays an important role for infants.[6] Studies suggest that a decline in melatonin levels is associated with dyslipidemia and obesity. Thus, melatonin is crucial for controlling excess weight gain and associated metabolic diseases.[7]

Obesity results from an imbalance between energy expenditure and food consumption, and excess calories are stored as triacylglycerol in white adipose tissue (WAT). Numerous other complications, including nonalcoholic fatty liver disease (NAFLD), cardiovascular disease, dyslipidemia, disorders of the neurological system, and type 2 diabetes mellitus, can be induced by obesity.[8] In recent years, the scientific community has made tremendous progress in understanding the causes and origins of obesity, including genetic, neuroendocrine, epigenetic, environmental, psychological, and social factors, as well as the consequences of eating disorders and lifestyle choices.

Because colostrum has a high concentration of immunologically active cells, alterations in its composition brought on by obesity may have an impact on the phagocytes' ability to function. Colostrum phagocytes have significant protective factors for newborns,[9] and in neonates, they protect against respiratory and gastrointestinal illnesses.[10] The effects of melatonin on the colostrum phagocytes of obese women are unknown, despite the fact that they can be altered by bioactive components such as hormones. Therefore, the purpose of this research is to examine the connection between adult BMI, serum melatonin, serum insulin, and serum lipid profile.

Materials and Methods

Study design and subjects

This cross-sectional study aimed to investigate the relationship between adult BMI, serum insulin, and lipid profiles with melatonin levels in obese individuals in Babylon province, Iraq. A total of 150 subjects (78 females and 72 males) aged 18–60 years wereenrolled in this study. Samples were taken at Imam al-Sadiq Hospital and Marjan Teaching Hospital in Babil Governorate under the supervision of the Department of Physiology, College of Medicine, University of Babylon, from 1st September 2023 to 30th June 2024.

Inclusion and exclusion criteria

Inclusion criteria included the following: any healthy adult patients without any diseases, adult of the age range 18–60 years including both sexes, and randomly selected adult patients in Merjan Teaching Hosipital from all consulting hospitals. Exclusion criteria included the following: melatonin intake or medications known to affect melatonin secretion, individuals with any chronic disease (such as HT, DM, or ischemic heart disease), and individuals with any systemic disease (such as SLE and MS).

Statistical analysis

The statistical software for Statistical Package for the Social Sciences (SPSS) version 27.0 (SPSS, IBM Company, Chicago, IL, USA) was used for the description, analysis, and display of the data. The ANOVA test was used to compare serum melatonin levels among different age groups. For quantitative variables, the means and standard deviations (SD) were employed. Frequencies and percentages were used for qualitative variables. The variances are considered significant when the probability (P) is less than 0.05 ($P < 0.05$) and highly significant when the probability (P) is less than 0.001 ($P < 0.001$).

Ethical approval

All individuals involved in this study were informed of the procedure, and consent was obtained verbally from each one before the collection of samples. The study was approved by the Committee on Publication Ethics at the College of Medicine, University of Babylon, Iraq, under the reference number 359 on August 22, 2023.

Measurement of BMI

The weight of each person enrolled in this study was measured using a weighing scale and their height using a metric tape measure. The BMI was calculated (weight in kg divided by height in square meters) (kg/m^2). The BMIs and classifications followed were according to Weir and Jan, 2019.[11]

Body weight was measured with a digital scale. Height was measured using a wall-mounted stadiometer. The BMI was calculated (weight in kilograms divided by the square of the height in meters). A general medical examination was performed. The results were interpreted using age- and sex-specific percentiles. Pubertal status was assessed according to Tanner criteria.

Biochemical analyses and calculations

Commercial test kits were used to measure the following parameters in blood samples: serum melatonin, serum insulin level, lipid status (total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides), and kidney function.

The following enzyme-linked immunosorbent assay (ELISA) kits were obtained from (Abbott GmbH and Co. KG, USA), with the exception of the lipid profile kit, which was obtained from (Goldsite Diagnostic Inc., China): melatonin kit, lipid profile kit, urea kit, creatinine kit, insulin kit, vitamin D kit, and HG kit.

Melatonin measurement

To estimate the cumulative overnight melatonin secretion, sulfatoxymelatonin (MT6s), the major metabolite of melatonin, was measured in the first-morning blood.[12] Therefore, subjects were asked to bring a sample of the first-morning blood on the day of examination.

Results

This study included a total of 150 patients, the mean age of participants was (32.0 ± 7.9) years, and the median was (31) years. Age group distribution of study patients is detailed in [Table 1].

Regarding gender distribution, the proportion of female patients was 52.0% compared to 48.0% for males. A higher proportion of patients were residents of rural areas (53.3%), while the remaining (46.7%) were residents of urban areas.

Mean BMI of study patients was 30.6 ± 8.3 kg/m^2. The majority (60.7%) of patients were obese (BMI ≥ 30),[Figure 1].

Study sample of blood parameters

- In this study, high serum melatonin levels were observed in overweight individuals and lower serum melatonin in the underweight group, with normal melatonin levels in the normal BMI group. As a result, there is an association between serum melatonin and BMI (an increase in BMI in serum melatonin).
- The results indicated that the serum insulin was low (in overweight individuals), the lipid profile was high, and vitamin D was low in the same group.
- In the high BMI group, there is low vitamin D in comparison with the normal BMI group. As a result, overweight (high BMI) people tend to have lower vitamin D levels. The results of all laboratory tests are provided in [Table 2].

Table 1: Age group distribution of study patients (n = 150)

Age group (years)	Frequency	(%)
<20	5	3.3%
20–29	50	33.3%
30–39	72	48.0%
40–49	17	11.3%
50–59	6	4.0%

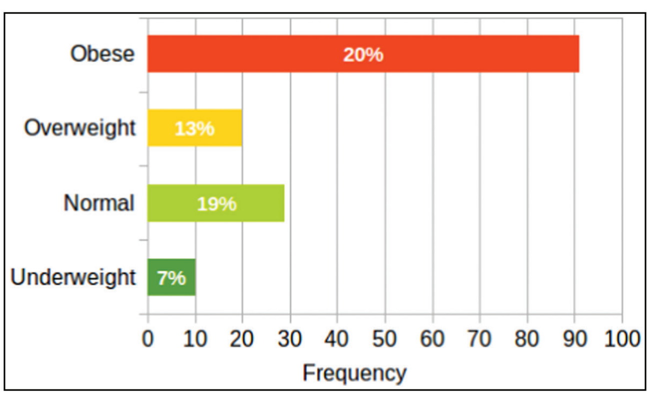

Figure 1: BMI classes of study patients (n = 150)

Correlation between age groups and serum melatonin

The ANOVA test was used to compare serum melatonin levels among age groups. There was a significant difference among age groups with a P value of 0.006 [Table 3].

Correlation between gender and melatonin

Comparison between males and females regarding serum melatonin demonstrated that there were no significant differences between them, P value = 0.383,[Table 4].

Table 2: Details of laboratory tests

Laboratory test	Mean	Standard deviations (SD)
Melatonin (pg/mL)	25.5	11.2
Hb	16.1	0.9
LDL	142.7	38.7
HDL	49.4	15.0
Total cholesterol	194.7	34.4
Triglycerides	188.0	107.4
Blood urea	21.9	4.5
Serum creatinine	0.9	0.1
RBS	145.1	19.8
Vitamin D	15.8	9.8
Serum insulin	11.0	5.2

Table 3: Comparison of serum melatonin with age group

Age group (years)	N	Serum melatonin (pg/mL) Mean ± SD	F	P value
<20	5	31.2 ± 12.4	3.74	0.006*
20–29	50	21.8 ± 11.5		
30–39	72	25.7 ± 11.0		
40–49	17	30.9 ± 8.6		
50–59	6	33.7 ± 4.0		

* Significant at $P \leq 0.05$

Table 4: Comparison of serum melatonin between males and females

Gender	N	Serum melatonin (pg/mL)			P value
		Mean	SD	Range	
Male	72	24.7	11.8	2.0–50.0	0.383
Female	78	26.3	10.6	2.0–40.0	
Total	150	25.5	11.2	2.0–50.0	

In a similar manner, no significant difference in serum melatonin was observed between people in urban residence (11.7 ± 11.7) and rural residence (26.9 ± 10.7), *P* value = 0.099.

Correlation between BMI and serum melatonin

Comparison among BMI classes regarding serum melatonin was conducted using ANOVA. A significant difference was observed among different BMI classes, *P* value < 0.001 [Table 5].

Correlation between the blood parameters and serum melatonin

Pearson's correlation coefficient was also calculated to assess the relationship between serum melatonin and blood parameters [Table 6]. Significant associations were observed between serum melatonin and each of Hb, LDL, HDL, vitamin D, insulin, total cholesterol, and triglycerides.

Discussion

The current study aims to find the association between serum melatonin and adult body mass index in Babylon province, examining any relationship between serum melatonin and BMI. To the best of our knowledge, this is the first study evaluating the association of serum melatonin with BMI, age, lipid profile (cholesterol, HDL, LDL, and TG), and serum insulin.

The high rise in the incidence of obesity among people in the Hispanic, Mexican, and American adults, including Iraq, is believed to be related to changes in socioeconomic features, low education, use of exogenous hormones, and changes in food intake.[13]

In the present study, the mean age of people with obesity was 32.3 ± 7.9 years, with the vast majority being more than 30 years of age. This result was compatible with that of Shabu[14] who found that the mean age in Iraqi patients was 33 years.

The current study revealed a significantly higher prevalence of overweight/obesity among the 30–39 year age group. These results were consistent with those conducted in Malta by Cuschieri *et al.*[15] who showed that those aged 34 years exhibited the highest prevalence of overweight for both genders. The results were somewhat similar in Iranian people, which revealed a mean age of 33 years for prevalence of obesity.[16]

In this study, most people with overweight and increased BMI living in rural areas (60%) compared urban areas (40%) may be related to a low socioeconomic status, and only few of them had a secondary school degree or higher education, as most Iraqi people come from low- to middle-income backgrounds. Those with a high socioeconomic status typically seek private healthcare facilities that we cannot access, and that was compatible with the result of Jessen *et al.*[17] Another point is that more than a quarter (27.1%) lived in rural areas with decreased services of screening and diagnosis for obesity.

According to this study, the prevalence of overweight and obesity is significantly higher in women compared to men, at 52% and 48%, respectively. These findings are consistent with those of an Iranian study that found a 53.3% and 47.7% prevalence rate, respectively, in males and females.[18] They also concur with results from a study

Table 5: Comparison among BMI classes regarding serum melatonin

Group	*N*	Serum melatonin (pg/mL) Mean ± SD	*P* value
Underweight (<18.5)	10	13.8 ± 11.5	**<0.001***
Normal (18.5-24.9)	29	17.7 ± 9.4	
Overweight (25.0-29.9)	20	24.3 ± 9.7	
Obese (≥30.0)	91	29.6 ± 9.8	
Total	150	25.5 ± 11.2	

*Significant at $P \leq 0.05$

Table 6: Correlations between serum melatonin and blood parameters

Blood parameters	Correlation with serum melatonin			
	Correlation coefficient (R)	Strength of association	Direction of association	*P* value
Hb	0.22	Small	Positive	**0.007***
LDL	0.44	Moderate	Positive	**<0.001***
HDL	-0.25	Small	Negative	**0.002***
Urea	0.05	Small	Positive	0.507
Creatinine	-0.07	Small	Negative	0.399
RBS	0.12	Small	Positive	0.156
Vitamin D	-0.47	Moderate	Negative	**<0.001***
Insulin	-0.16	Small	Negative	**0.045***
Total cholesterol	0.39	Moderate	Positive	**<0.001***
Triglycerides	0.37	Moderate	Positive	**<0.001***

*Significant at $P < 0.05$. Hb = hemoglobin; LDL = low-density lipoprotein; HDL = high-density lipoprotein; RBS = random blood sugar conducted in Basrah, which showed a frequency of 45.3% in men and 54.7% in women.[19]

In this study, an increase in serum melatonin with obesity was observed, indicating a close relationship between melatonin secretion and obesity in adults, which is almost similar to the results reported previously.[17] In our study, two-thirds of patients were either overweight or obese (BMI > 25 Kg/m^2). This was compatible with the findings of several studies that showed the risk of obesity on melatonin secretion increases with increasing BMI.[20] A possible explanation of the increasing proportion of overweight and obese individuals in our study is that obesity is linked to decreased melatonin concentration.

This study aimed to evaluate the relationship between age and melatonin levels, phenotype, and metabolic parameters. Consistent with other research studies, we observed that melatonin secretion was negatively linked with increasing age.[21]

Our results further demonstrated that higher age is associated with a decrease in serum melatonin. Kozirog *et al.*[22] showed that older people who sleep less have lower serum melatonin levels.

Melatonin has a role in glucose tolerance. There is an association between the concentration of melatonin and insulin resistance and BMI with serum insulin. Here, the nocturnal secretion of melatonin was decreased in obese patients who were insulin-resistant. These findings are also in line with those of experimental and clinical research on adults that showed a robust correlation between low insulin/glucose metabolism and melatonin.[1]

Polymorphisms of the melatonin receptor (MTNR1B), which are linked to an increased risk of glucose intolerance in children and adolescents, may be one of the underlying mechanisms. Pancreatic β-cells have melatonin receptors (MT1 and MT2), and studies have shown that melatonin inhibits insulin production through the cAMP and cGMP pathways.[23]

Additionally, in line with adult studies, patients with increased insulin secretion also had reduced melatonin secretion. Changes in melatonin secretion may be related to elevated insulin levels, which are also known to be an independent risk factor for cardiovascular diseases.[24] A study by Mayo *et al.*[25] found that melatonin can reduce systemic inflammation brought on by elevated insulin levels by inhibiting cyclooxygenase 2, which may lessen mitochondrial dysfunction.

In the present study, two-thirds of people found with increased serum lipid profile levels (LDL, total cholesterol, and TG), except HDL-cholesterol, were normal because over two-thirds of them were overweight and obese (BMI > 25 Kg/m^2). This result was compatible with that of Silitonga *et al.*[26] The excess of body fat is due to greater energy intake compared to the energy expenditure. Obesity has been associated with an increased risk for metabolic syndrome in adults.[27]

Further regression analysis revealed a substantial correlation between triglyceride levels and melatonin secretion, consistent with several studies reporting melatonin's hypolipidemic effect in adult patients with type 2 diabetes.[20]

Remarkably, contrary to other research works on adults, we only discovered meaningful correlations with one aspect of the metabolic syndrome (hypertriglyceridemia) and not with the entire metabolic syndrome.[28] Additionally, owing to the narrow range of BMI-SDS, a strong association between obesity and melatonin secretion was found. Nonetheless, there is compelling evidence from experimental data indicating that melatonin has a role in the control of body fat and energy metabolism[17]

A significant association was observed between serum melatonin and Hb ($R = 0.22$, $P = 0.007$) and the concentration of melatonin and Hb. The increased serum melatonin in healthy humans leads to a significant increase in the hemoglobin level, especially against a background of low values.

A significant association was observed between serum melatonin and vitamin D ($R = -0.47$, $P < 0.001$). The most likely explanation for the inverse connection between serum melatonin levels and BMI in vitamin D is volumetric dilution of the vitamin. Because VD is dispersed over a larger volume in overweight individuals, serum concentrations are lower. Specifically, the liver, muscle, fat, and serum—compartments that are elevated in obesity—are where 25(OH) D is primarily distributed. This can be explained by the fact that the difference in serum vitamin D concentration between normal weight and obese groups is significantly influenced by seasonal variation.

Conclusion

There is a link between insulin resistance and melatonin release, with higher melatonin levels leading to increased insulin resistance. The high-BMI groups showed higher melatonin concentrations. The serum insulin is high in (overweight) and high lipid profile and low vitamin D in the same group. In the high-BMI group, there is low vitamin D compared with normal BMI groups that have normal vitamin D. Thus, overweight (high BMI) people tend to have lower vitamin D levels. High serum melatonin is observed in overweight, lower serum melatonin in underweight, and normal melatonin levels in normal BMI groups.

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Conflicts of interest

There are no conflicts of interest.

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